2.2 Core-Argo profile format version 3.0

An Argo single-cycle profile file contains a set of profiles from a single cycle. The minimum number is one profile per cycle. There is no defined maximum number of profiles per cycle.

~~A profile contains all parameters that are measured with the same vertical sampling scheme and at the same location and time. For example, all Argo floats collect at least one profile per cycle that contains the CTD measurements.~~

A core-Argo profile contains the CTD sensor parameters (pressure, temperature, salinity, conductivity) that are measured with the same vertical sampling scheme and at the same location and time. Additional parameters from other sensors are stored in a B-Argo profile file. The B-profile file is very similar to core-Argo profile file; its additional features are listed in §2.6

Some speciality floats collect additional profiles per cycle. These speciality profiles contain parameters measured at pressure levels that are different from the CTD levels, and can be at locations and time that are different from the primary profile. When multiple profiles exist in a single cycle, users are urged to check the information associated with each profile in order to determine their spatial and temporal relations. Some examples of speciality profiles with different vertical sampling schemes are:

- Bouncing profiles: a series of shallow profiles performed during one cycle.
- High resolution near-surface observations: higher resolution vertical sampling near the surface from unpumped CTD.
- ~~Oxygen profiles: dissolved oxygen measured on vertical levels that are not the CTD levels.~~
- ~~Optical profiles: a series of optical profiles performed during one cycle.~~

For single-cycle profile file naming conventions, see §4.1.

2.2.1 Global attributes

The global attributes section is used for data discovery. The following global attributes should appear in the global section. The NetCDF Climate and Forecast (CF) Metadata Conventions (version 1.6, 5 December, 2011) are available from:

- http://cf-pcmdi.llnl.gov/documents/cf-conventions/1.6/cf-conventions.pdf

// global attributes:
:title = "Argo float vertical profile";
:institution = "CSIRO";
:source = "Argo float";
:history = "2011-04-22T06:00:00Z creation";
:references = "http://www.argodatamgt.org/Documentation";
:comment = "free text";
:user_manual_version = "3.04";
:Conventions = "Argo-3.0 CF-1.6";
:featureType = "trajectoryProfile";

Global attribute name	Definition
title	A succinct description of what is in the dataset.
institution	Specifies where the original data was produced.
source	The method of production of the original data. If it was model-generated, source should name the model and its version, as specifically as could be useful. If it is observational, source should characterize it (e.g., "surface observation" or "radiosonde").

2.3 Core-Argo trajectory format version 3.0

Core-Argo trajectory files contain all received locations of Argo floats. The trajectory file also contains cycle timing information important for making velocity calculations. These times may come directly from the float in real time, from calculations based on float information in real time, from the satellite system in real time, or from estimations done in delayed mode.

In addition to locations and cycle timing information, a trajectory file often contains measurements such as pressure, temperature, salinity or conductivity performed at various times during the cycle. The full pressure, temperature and salinity profile collected upon ascent is not included in the trajectory file. This is stored in the profile file.

A core-Argo trajectory contains the CTD sensor parameters (pressure, temperature, salinity, conductivity) that are measured outside the vertical profiles. Additional parameters from other sensors are stored in a B-Argo trajectory file. The B-trajectory file is very similar to core-Argo trajectory file; its additional features are listed in §2.6

There will be up to two possible Core-Argo trajectory files at one time for a float - a real time trajectory file ("R") and a delayed mode trajectory file ("D"). For naming conventions, see §4.1.3. The real time trajectory file will contain all the data obtained in real time for all the cycles the float has performed. The "R" file will exist until the float dies and a delayed mode trajectory file exists for the entire float lifetime.

The delayed mode trajectory file will contain both real time and delayed mode data. The delayed mode data will be the highest quality data available for each cycle that has been delayed mode quality controlled. However, delayed mode quality control may not be performed on all the float's cycles. In this case, the "D" file will contain both the real time and delayed mode data only for the cycles for which delayed mode quality control has been performed. Therefore, if both an "R" and "D" trajectory file exist, to obtain the best quality data for the entire float record, one must look at the "D" file for the cycles that have been delayed mode quality controlled and then in the "R" file for the rest of the cycles which have not yet been delayed mode quality controlled. Once a float dies and the entire float record has been quality controlled, the "D" file will be the only file available on the GDAC and will contain both adjusted and not adjusted data.

The trajectory file contains two groups of data variables. In this document the groups are differentiated by their dimension.

The variable group described in §2.3.5 which includes the locations, cycle timing information, and measurements from the float is N_MEASUREMENT long. It includes all the raw data from the float and there is no complimentary variable in the N_CYCLE variable group. If filled, the best timing information is kept in the JULD_ADJUSTED variable. If this is filled in real time, that means either clock drift has been determined and adjustment has been applied (inclusive of adjustment of zero) or another timing estimate has been done based on typical float behavior. Simultaneously, the DATA_MODE should be marked as "A" indicating an adjusted float, and the CLOCK_OFFSET variable should be appropriately filled.

The variable group described in §2.3.6 which includes the cycle timing information is N_CYCLE long. This array includes the best timing information which matches, if filled, the JULD_ADJUSTED times in the N_MEASUREMENT array, else it matches the JULD (N_MEASUREMENT) variable. The times can be corrected for float clock drift or estimated. The JULD*STATUS variables provide information on the state of the timing information. The N_CYCLE array also includes several variables that pertain only to the entire cycle such as GROUNDED, CONFIG_MISSION_NUMBER, etc.

In the N_MEASUREMENT group, the MEASUREMENT_CODE variable must be correctly understood. This variable is designed to indicate where in the cycle the location, times and

2.6 B-Argo profile and trajectory format additional features

A B-Argo profile/trajectory file contains all the parameters from a float, except the core-Argo parameters temperature, salinity, conductivity (TEMP, PSAL, CNDC). A float that performs only CTD measurements does not have B-Argo data files.

To accommodate non-core parameters, a series of optional addition to core-Argo profile/trajectory formats are listed here.

2.6.1 Management of array values

Observations are usually one dimension variables, such as temperature or salinity. However, some sensors provide multi-dimensional variables.
For example, an optical sensor for Nitrate reports a spectrum of up to 41 values for each measurement, one per wavelenght.

When needed, an additional dimension is added to report the N sublevels of spectrum observation performed on each level.

- float <PARAM>(N_PROF, N_LEVELS, N_VALUES);

Example of 60 measurements of “DOWNWELLING_IRRADIANCE_RAW” parameter performed at each 41 wavelengths of an individual profile.

- NPROF = 1
- N_LEVELS = 60
- N_VALUES = 41

The N_VALUES dimension is used only when it is necessary : if there is more than one value for each level (N_VALUES > 1).

N_VALUES	N_VALUES = <int value> ;	Maximum number of parameter measurements sampled at a given pressure level. This dimension depends on the data set. Example : N_VALUES = 41

To describe wavelengths of the sensor (41 in the example), an attribute of the variable called wave_length_nanometer provides the list

double DOWNWELLING_IRRADIANCE_RAW(N_PROF, N_LEVELS, N_VALUES) ;
DOWNWELLING_IRRADIANCE_RAW:long_name = "IRRADIANCE COUNTS FROM OCR SENSOR" ;
DOWNWELLING_IRRADIANCE_RAW:standard_name = "TBD" ;
DOWNWELLING_IRRADIANCE_RAW:_FillValue = 99999. ;
DOWNWELLING_IRRADIANCE_RAW:units = "counts" ;
DOWNWELLING_IRRADIANCE_RAW:valid_min = "TBD" ;
DOWNWELLING_IRRADIANCE_RAW:valid_max = "TBD" ;
DOWNWELLING_IRRADIANCE_RAW:C_format = "%10.0f" ;
DOWNWELLING_IRRADIANCE_RAW:FORTRAN_format = "F10.0" ;
DOWNWELLING_IRRADIANCE_RAW:resolution = 1. ;
DOWNWELLING_IRRADIANCE_RAW:wave_length_nanometer = "115 132 149 166 183 200 217 234 251 268 285 302 319 336 353 370 387 404 421 438 455 472 489 506 523 540 557 574 591 608 625 642 659 676 693 710 727 744 761 778 795" ;

2.6.2 Parameter values may be float or double

Some sensors provide values that cannot be stored as float, but has to be stored as double. In that case, a variable with the type “double” is used instead of a “float” variable.

These parameters are precursor to calculated parameters. They will not be ajusted or quality controlled (no record in history or calibration sections).

Concerned variables

PROF & TRAJ: <PARAM> and HISTORY_PREVIOUS_VALUE.

Example: DOWNWELLING_IRRADIANCE_RAW: counts provided by the OCR sensor of the ProvBio II Remocean float.

2.6.3 Parameter data_mode

The existing data_mode variable is not related to a specific parameter. In B-Argo data files, a data_mode = ‘D’ describes a file with one or more adjusted parameter.

In B-Argo data files, delayed mode adjustment is performed on additional parameters such as oxygen. When relevant add a data mode related to each parameters of the file.

PARAMETER_DATA_MODE	char PARAMETER_DATA_MODE(N_ PROF, N_PARAM); PARAMETER_DATA_MODE:long_name = "Delayed mode or real time data"; PARAMETER_DATA_MODE:conventions = "R : real time; D : delayed mode; A : real time with adjustment"; PARAMETER_DATA_MODE:_FillValue = " ";	Describe the data mode of the individual parameter : R : real time data D : delayed mode data A : real time data with adjusted values

2.6.4 PARAMETER names on 64 characters

B-Argo parameter variables is extended from 16 to 64 characters.

Applicable variables

In profile files: STATION_PARAMETERS, PARAMETER, HISTORY_PARAMETER

In trajectory files: TRAJECTORY_PARAMETERS, HISTORY_PARAMETER

In metadata files: PARAMETER size is set to 64, PARAMETER_SENSOR size is set to 128

3.3 Reference table 3: parameter code table

The following table describes the parameter codes used for Argo data management. The detailed parameter codes tables is available on Argo data-management web site:

- http://www.argodatamgt.org/Documentation/xxx (not yet online)

Core-Argo parameters

Parameter name	long_name	cf standard_name	unit	valid_min	valid_max
CNDC	Electrical conductivity	sea_water_electrical_conductivity	mhos/m	0.f	8.5f
PRES	Sea water pressure, equals 0 at sea-level	sea_water_pressure	decibar	0.f	12000.f
PSAL	Practical salinity	sea_water_salinity	psu	0.f	42.f
TEMP	Sea temperature in-situ ITS-90 scale	sea_water_temperature	degree_Celsius	-2.f	40.f

B-Argo parameters

Parameter name	long_name	cf standard_name	unit	valid_min	valid_max
DOXY	Dissolved oxygen	moles_of_oxygen_per_unit_mass_in_sea_water	micromole/kg	0.f	650.f
TURBIDITY	Sea water turbidity	sea_water_turbidity	ntu	-	-
CHLA	Chlorophyll-A	mass_concentration_of_chlorophyll_a_in_sea_water	mg/m3	-	-
CDOM	Concentration of coloured dissolved organic matter in sea water	-	ppb	-	-
NITRATE	Nitrate	moles_of_nitrate_per_unit_mass_in_sea_water	micromoles/kg	-	-
BISULFIDE	Bisulfide	-	micromoles/kg	-	-
PH_IN_SITU_TOTAL	pH	sea_water_ph_reported_on_total_scale	dimensionless	-	-

Intermediate parameters

These parameters are reported in data files. They are ignored in the files merged by GDACs.

Parameter name	long_name	cf standard_name	unit	valid_min	valid_max
TEMP_DOXY	Sea temperature from oxygene sensor ITS-90 scale	temperature_of_sensor_for_oxygen_in_sea_water	degree_Celsius	-2.f	40.f
VOLTAGE_DOXY	Voltage reported by oxygen sensor	-	volt	0.f	100.f
FREQUENCY_DOXY	Frequency reported by oxygen sensor	-	hertz	0.f	25000.f
COUNT_DOXY	Count reported by oxygen sensor	-		0.f	100.f
BPHASE_DOXY	Uncalibrated phase shift reported by oxygen sensor	-	degree	10.f	70.f
DPHASE_DOXY	Calibrated phase shift reported by oxygen sensor	-	degree	10.f	70.f
TPHASE_DOXY	Uncalibrated phase shift reported by oxygen sensor	-	degree	10.f	70.f
C1PHASE_DOXY	Uncalibrated phase shift reported by oxygen sensor	-	degree	10.f	70.f
C2PHASE_DOXY	Uncalibrated phase shift reported by oxygen sensor	-	degree	10.f	70.f

MOLAR_DOXY	Uncompensated (pressure and salinity) oxygen concentration reported by the oxygen sensor	mole_concentration_of_dissolved_molecular_oxygen_in_sea_water	micromole/litre	0.f	650.f
PHASE_DOXY	Phase shift reported by oxygen sensor	-	micro seconds	10.f	70.f
MLPL_DOXY	Oxygen concentration reported by the oxygen sensor	-	ml/l	0.f	650.f
NB_SAMPLE	Number of samples in bin	-	none		
RPHASE_DOXY	Uncalibrated red phase shift reported by oxygen sensor	-	degree	10.f	70.f
OPTICAL_WAVELENGTH_CHLA	Optical wavelength from chlorophyll-A sensor	radiation_wavelength	nm	-	-
OPTICAL_WAVELENGTH_BACKSCATTER	Optical wavelength from optical backscattering sensor	radiation_wavelength	nm	-	-
OPTICAL_WAVELENGTH_CDOM	Optical wavelength from colored dissolved organic matter sensor	radiation_wavelength	nm	-	-
BETA_BACKSCATTERING	Total angle specific volume from backscattering sensor	-	counts	-	-
FLUORESCENCE_CHLA	Chlorophyll-A signal from fluorescence sensor	-	counts	-	-
TEMP_CPU_CHLA	Thermistor signal from backscattering sensor	-	counts	-	-

FLUORESCENCE_CDOM	Raw fluorescence from colored dissolved organic mater sensor	-	counts	-	-
SIDE_SCATTERING_TURBIDITY	Turbidity signal from side scattering sensor	-	counts	-	-
TRANSMITTANCE_PARTICLE_BEAM_ATTENUATION	Beam attenuation from transmissiometer sensor	-	counts	-	-
PARTICLE_BACKSCATTERING	Particle backscattering	-	m-1	-	-
PARTICLE_BEAM_ATTENUATION	Particle beam attenuation	-	m-1	-	-
OPTICAL_WAVELENGTH_UV_NITRATE	Optical ultra-violet wavelength from nitrate sensor	radiation_wavelength	nm	-	-
UV_INTENSITY_NITRATE	Intensity of ultra violet flux from nitrate sensor	-	counts 16-bit	-	-
UV_INTENSITY_DARK_NITRATE	Intensity of ultra violet flux dark measurement from nitrate sensor	-	counts 16-bit	-	-
UV_INTENSITY_DARK_SEAWATER_NITRATE	Intensity of ultra-violet flux dark sea water from nitrate sensor	-	counts 16-bit	-	-
E_NITRATE	E nitrate	-	liter/micromol cm	-	-
UV_INTENSITY_REF_NITRATE	Ultra-violet intensity reference from nitrate sensor	-	counts 16-bit	-	-
E_SWA_NITRATE	E SWA nitrate	-	dimensionless	-	-

TEMP_CAL_NITRATE	Temperature calibration from nitrate sensor	-	degree_Celsius	-	-
ABSORBANCE_COR_NITRATE	Absorbance from nitrate sensor	-	dimensionless	-	-
MOLAR_NITRATE	Nitrate	-	micromoles/l	-	-
FIT_ERROR_NITRATE	Nitrate fit error	-	dimensionless	-	-
VRS_PH	Voltage difference between reference and source from pH sensor	-	volt	-	-
PH_IN_SITU_FREE	pH	-	dimensionless	-	-
PH_IN_SITU_SEAWATER	pH	-	dimensionless	-	-
OPTICAL_WAVELENGTH_RADIANCE	Optical wavelength radiance	radiation_wavelength	nm	-	-
OPTICAL_WAVELENGTH_IRRADIANCE	Optical wavelength irradiance	radiation_wavelength	nm	-	-
DOWNWELLING_IRRADIANCE_RAW	Raw downwelling irradiance	-	counts	-	-
DOWNWELLING_IRRADIANCE	Downwelling irradiance	-	W/m^2/nm	-	-
RAW_UPWELLING_RADIANCE	Raw upwelling radiance	-	counts	-	-
UPWELLING_RADIANCE	Upwelling radiance	upwelling_radiance_in_sea_water	s	-	-
RAW_DOWNWELLING_PAR	Raw downwelling photosynthetic available radiation	-	counts	-	-
DOWNWELLING_PAR	Downwelling photosynthetic available radiation	downwelling_photosynthetic_radiance_in_sea_water	microMoleQuanta/m2/sec	-	-

Parameter attributes

- The Fill_value attribute is set to 99999.f
- The C_Format, Fortran_Format and Format_resolution attributes are float/sensor dependants. They are set by the DAC (Data Assembly Centre).

If new parameters are required, they have to be added to this table before they will be accepted.
A request for new parameters can be sent to argo-dm-chairman@jcommops.org for approval and inclusion.

Note on resolution

For each parameter, the resolution attribute is mandatory. However, the resolution value is sensor dependant.

3.3.1 Parameters from duplicate sensors

Some floats are equipped with 2 different sensors, measuring the same physical parameter. In that case, add the integer "2" at the end of the code of the duplicate parameter (e.g. DOXY2).

If more sensors that measure the same physical parameter are added, then the integer will simply increase by 1 (i.e. DOXY3, DOXY4, and so on).

Example

If a float has one Optode and one SBE oxygen sensor:

- Use DOXY and TEMP_DOXY for Optode
- Use DOXY2 for SBE

If a float has two Optode oxygen sensors:

- Use DOXY and TEMP_DOXY, and DOXY2 and TEMP_DOXY2

If a float has two SBE oxygen sensors:

- Use DOXY and DOXY2

3.3.2 Oxygen related parameters

Some Argo floats perform Oxygen observation from different types of sensors, such as the Aandera Optode or the Seabird SBE 43/IDO.

To provide homogeneous observations from heterogeneous sensors, oxygen measurement should be converted and reported as DOXY.

- DOXY is the dissolved oxygen concentration estimated from the telemetered, calibrations coefficients and CTD values: PRES, TEMP (or TEMP_DOXY) and PSAL.
  Pressure and salinity compensations (e.g. Optode) are taken into account.
- DOXY unit: micromole/kg
- DOXY_ADJUSTED is the dissolved oxygen concentration corrected for any sensor drift and offset. DOXY_ADJUSTED is calculated from the other “ADJUSTED” fields.